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ISSN 2348 – 8034
Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

EXPERIMENTAL INVESTIGATION OF CONCRETE STRENGTH WITH PARTIAL REPLACEMENT OF CEMENT BY GRANITE BY PRODUCT

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ABSTRACT

The production of Ordinary Portland Cement (OPC), the chief ingredient of normal concrete unfortunately, emits vast amounts of carbon-dioxide gas into the atmosphere causing global warming. Hence it is imperative to use either alternate or other materials as partial replacement. Granite Powder is the most commonly used mineral admixture in high strength concrete. It has become the chosen favorites for high strength concrete and is a good pozzolan and can be used in a big way. Adding Granite powder to the concrete mix will dramatically enhance the compressive strength and impermeability of concrete mixes apart from making the concrete durable against chemical attacks, abrasion as well as reinforcement corrosion. In the present study, in concrete mix of M30 grade, the cement is replaced with Granite Powder by 10%, 20%, 30% and 40%. The compressive strength and Split tensile strength of Cube and Cylinder Specimens were determined after curing them for different periods. The cubes and Cylinders samples were tested after curing them for a period of 7, 14 and 28 days.

The test results revealed that there is an increase in the Compressive strength and Split Tensile Strength up to 20% replacement by Granite powder when compared with the control concrete prepared without any mineral admixture. Further addition of Granite Powder beyond 20% replacement resulted in slight decrease in strength.

Keywords*: Cement, Granite Powder, compressive strength and split tensile strength.*

I. INTRODUCTION

Concrete is the most widely used man-made construction material in Civil Engineering applications such as buildings, roads, bridges, dams, power plants, flooring, etc. Compared to other building materials, concrete can be formed into a variety of shapes and sizes right at the construction site or in the form of precast elements

The rapid increase in the annual consumption of natural aggregates due to the expansion of the construction industry worldwide means that aggregate reserves are being depleted rapidly, particularly in desert regions. It has been reported that, if alternative aggregates are not utilized in the near future, the concrete industry will globally consume 8-12 billion tons of natural aggregates annually after the year 2010. Disposing the waste material directly in open yards can cause environmental problems. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. It is estimated that cement production is responsible for about 3% of the global androgenic greenhouse gas emission and for 5% of the global androgenic CO_2 emission, As about 50% of the CO_2 released during cement production is related to the decomposition of limestone during burning mixing of clinker with supplementary material called blending is considered as a very effective way to reduce CO_2 emission.

In India, the marble and granite stone processing are most flourishing industries responsible for producing lot of dust as waste material. In the present study, the effect of marble dust on the physical and mechanical properties of fresh and hardened concrete have been investigated. The cost of construction materials is increasing incrementally every year leading to increase of overall construction cost. In India the cost of cement during 1995 was Rs. 1.25per kg but in 2012 the price is increased nearly 5 times. In an attempt to reduce the cost of construction materials and overall construction cost, efforts are made to study the effect of granite powder as a partial replacement for cement.

ISSN 2348 – 8034
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Yash Agrawal1 Rajat Saxena [1] et al (2017) With the increasing cost of construction materials, there is a need to curtail the cost by using cheaper substitutes. This review deals with how Granite Slurry Waste can be used to produce new products or can be used as admixtures. For sustainable development natural resources are used more effectively and efficiently so that the environment is protected from waste deposits. Granite stone industry generates both solid waste and stone slurry. Granite powder is one of the materials which severalty affects the environment and health problems. It is produced from sawing, shaping, and polishing process. This review presents the use of granite slurry waste as replacement of cement and sand in several industrial applications such as mortar, concrete, composite material and bricks.

S.Arulkesavan1 [2] (2017) This project report summarizes the strength behavior of partial replacement of fine aggregate in concrete by Granite fine. Granite fines are the byproduct of granite industries while cutting huge granite rocks to the desired shapes. The granite powder from factory is carried by the water and stored in tanks. Concrete is prepared with granite fines as a partial replacement of fine aggregate in different proportions, 10%, 15%, and 20%. Various tests such as compressive strength, split tensile strength and flexural strength are conducted and the results are compared with the conventional concrete.

T. Shanmugapriya et al[3] (2016) The main objective of this study is to check the strength and durability characteristics of High Performance Concrete (HPC) using manufactured sand (M-Sand) along with 5% silica fume. The natural sand was replaced by M-Sand in the range of 0% to 100% in increments of 20%. The compressive strength, flexural strength, splitting tensile and modulus of elasticity were studied. Similarly the durability properties like sorptivity and Rapid Chloride Permeability test were also conducted. The results indicated that a marginal increase in strength and durability properties of high performance concrete by addition of manufactured sand as a complete replacement of natural sand.

Yogeswari1 et al [4] (2015) **T**his project aims to utilize the granite waste in an effective way by studying the strength properties of M30 grade concrete such as Compressive Split tensile and Flexural strengths with different percentage of replacements. The fine aggregate is replaced by granite waste (GW) in increments of 5% in the range of 5% to 25%. The optimum percentage of granite waste replacement in concrete corresponding to maximum strengths will be identified. Keeping this optimum percentage of granite powder replacement as constant, cement is replaced with mineral admixtures (MA) such as Silica Fume (SF) (5%, 10%, 15%, 20%) and Metakaolin (MK) (5%, 10%, 15%, 20%, 25%) separately to study the strength properties of concrete.. It was observed that the maximum increase in strength properties compared to conventional concrete was achieved at 15% replacement of granite waste. Based on the results obtained, the combination of GW (15%) with Metakaolin showed better performance than GW (15%) with silica fume.

Abhishek Mathur [5] et al (2015) Theuse of river sand confirming to IS 383-1970 has become difficult because of non availability, prohibitive cost and environmental rules and regulations. To overcome this difficulty, an economical alternative can be developed by partial replacement of sand with granite quarry dust (GD) and cement with marble powder (MP) in concrete. In this paper, a study is conducted to investigate the viable use of marble granite residue (MGR) in concrete mixes. Sand is replaced with GD along with cement (OPC grade 43) is replaced with MP as 0%, 10%, 20%, 30% & 40% by weight for M25 grade of concrete. To study strength and durability properties of concrete, test on fresh and hardened concrete are conducted for all the mixes. The results show that MGR assimilation results enhancements in the compressive strengths of concrete by replacement up to 20% of GD and 10% of MP without affecting significant characteristics of the mix. Optimum dose of super plasticizers is also suggested to improve workability. The analysis confirmed that MGR are non-reactive materials and can act as a filler in concrete. They can be used as a sustainable replacement for cement and fine aggregate.

Dr.T. Felix Kala[6] et al (2013) This paper focuses on the experimental study of using locally available granite powder as fine aggregate and partial replacement of cement with admixtures in the production of M60 concrete. The percentage of granite powder added by weight was 0, 25, 50, 75 and 100% as a replacement of sand used in concrete and cement was replaced with 7.5 % silica fume, 10% fly ash, 10% slag along with superplasticiser 1% by weight of cement. The test results show clearly that granite powder of marginal quantity, as partial sand replacement has

ISSN 2348 – 8034
Impact Factor- 5.070

beneficial effect on the mechanical properties. The highest strength has been achieved in samples containing 25% granite powder along with the other admixtures.

Narayana [7] (2012). Numerous research works have been carried out to assess the mechanical properties of concrete like compressive strength, flexural strength, and tensile strength. This review paper shows the results obtained from experimental results by various researchers on the effects of different types of fine aggregate on mechanical properties of concrete. The review of these papers has shown that the performance of manufactured sand and copper slag as fine aggregate in concrete is better when replaced with natural river sand. The percentage of replacement of natural sand by fly ash up to 40% in concrete subjected to elevated temperature of 200°C has shown increase in tensile strength.

II. EXPERIMENTAL PROGRAMME

Objectives:
The main objective of this experimental work is to search an replacement of cement by Granite Powder (Industrial Waste).

It is aimed to study the performance of Granite Powder in the concrete with respect to the strength properties.
Objectives of the experimental investigation are as follows:

- To study the mechanical properties such as compressive strength, split tensile strength of concrete at the end of 7, 14 and 28 days of curing period with partial replacement of cement by Granite Powder
- To compare the mechanical properties of concrete by replacement of Granite Powder in increments of 10%, 20%, 30% and 40% with that of control concrete.
- To determine the optimum replacement of cement by Granite Powder.

Materials Used
The materials used in this experiment were cement, Granite powder, fine aggregate, coarse aggregate and water.
1) Cement:
OPC 53 grade cement conforming to IS 8112-1989, from a single batch was used throughout the course of the project work. In laboratory various tests were conducted on cement and its results are shown in Table1

Table 1. Properties of Cement

S.No	Characteristics	Values
1	Consistency	32%
2	Initial Setting Time	42min
3	Final Setting Time	280 min
4	Finesse of cement	2%
5	Soundness of cement	4mm

2) Fine Aggregate:
Locally available river sand confirming to zone II was used in the present work (IS 383-1970). The sieve analysis data and physical properties of fine aggregates used are shown in Table 2.

Table 2. Properties of Fine aggregates

S.No	Characteristics	Values
1.	Type	Uncrushed (natural)
2.	Specific gravity	2.67
3.	Bulk Density	1668 kg/m3
4.	Fineness modulus	2.74
5.	Grading zone	Zone II

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3) Coarse Aggregate:
Locally available coarse aggregate having the maximum size of 20mm were used in the study. Properties of the coarse aggregate are tabulated in Table 3

Table 3. Properties of Coarse aggregates

S.No	Characteristics	Values
1.	Type	Crushed
2.	Specific gravity	2.6
3.	Bulk Density	1765 kg/m3
4.	Fineness modulus	6.55
5.	Maximum size	20mm

4) Water:
Potable clean water was used in the present investigation for both casting and curing of concrete.

5) Granite Powder:
SiO_2 -59.58%,Al_2O_3-13.01,TiO_2-.35%,Fe_2O3-9.77%,Mno-.17%,MgO-.29,CaO-3.8%,K2O-4.76%,Na_2O-5.92-LoI-1.56%

III. MIX PROPORTION OF CONCRETE

3.1 Trail Mix Design
Fresh state properties of concrete: Slump cone test is carried out in order to fix the w/c ratio for 1:1.54:2.42:0.45 mix.

Table 4: Slump values for various w/c ratios

S.No	w/c ratio	Slump Value(mm)	Remark
1	0.4	5	Dry mix
2	0.41	20	Dry mix
3	0.42	50	Dry mix
4	0.43	105	Workable mix
5	0.44	130	Workable mix
6	0.45	150	Workable mix

Mix Design:
In this study, control mix was designed as per IS 10262:2009 for M30 grade. Cement Replacement levels of 0%, 10%, 20%, 30% and 40% with Granite powder replacement are used. The mix proportions of all the mixes are presented in the table.5

Table 5: Mix proportions for varying replacement proportions of cement with Granite Powder with water cement ratio = 0.45

S/ No	Components	Replacement of Fine aggregate by Granite powder(Kg/m^3)				
		0%	10%	20%	30%	40%
1	Water	197	197	197	197	197
2	Cement	389.73	350.76	311.79	273.82	233.84
3	Sand	677.49	677.49	677.49	677.49	677.49
4	Granite powder	0	38.97	77.94	116.91	155.89
5	Coarse aggregate	1059.66	1059.66	1059.66	1059.66	1059.66
6	Water Cement Ratio = 0.45					
7	Super Plasticizer = 3.8 kg/m^3					

ISSN 2348 – 8034
Impact Factor- 5.070

IV. RESULT AND DISCUSSION

The result of compressive strength tests are tabulated in Table 6. From the results, it was observed that the compression strength of the concrete increases with increase in the replacement level of cement by Granite Powder up to 20%, beyond that level there was a marginal decrease in the strength of the concrete.

Comparison of strength of concrete with replacement of Cement by Granite Powder to the conventional concrete:
For 7 days curing period, the strength of the concrete is increased about **9.42%, 14.80%, 4.45%, and 10.66%** for 10% 20%,30% and 40 % replacement of Granite Powder respectively when compared with that of conventional concrete.

For 14 days curing period, the strength of the concrete is increased about **10.73%,15.82%, 3.06%** and **5.05%** for 10%, 20% 30%, and 40 % replacement of Granite Powder respectively when compared with that of conventional concrete.

For 28 days curing period, the strength of the concrete is increased about **9.45%, 13.11%, 2.48%** and **12.53%** for 10%, 20% 30% and 40% replacement of Granite Powder respectively when compared with that of conventional concrete

Table: 6 Compressive strength of Cubes with Granite Powder Replacement

Compressive strength of cubes in N/mm^2				
S.NO	**Proportions**	**7days**	**14days**	**28 days**
1	OPC + 0% Granite Powder	30.67	33.25	38.3
2	OPC + 10% Granite Powder	33.86	37.25	42.3
3	OPC + 20% Granite Powder	36	39.5	44.08
4	OPC + 30% Granite Powder	32.1	34.3	37.35
5	OPC + 40% Granite Powder	27.4	31.57	33.5

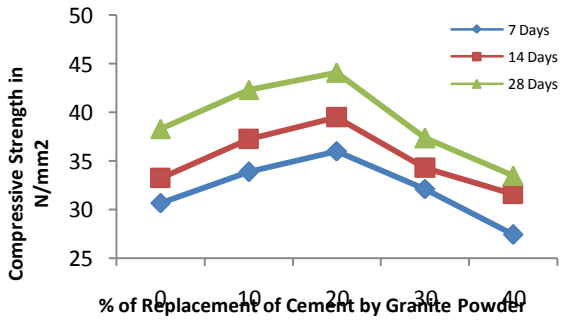

Fig. 1 Compressive strength V/s %Replacement of Cement by Granite Powder

Split Tensile Strength:
The result of Split Tensilestrength tests are tabulated in Tables 7 From the results, it was observed that Split Tensilee strength of the concrete increases with increase in the replacement level of cement by Granite Powder up to 20%, beyond that level there was a marginal decrease in the strength of the concrete.

Comparison of strength of concrete with replacement of Cement by Granite Powder to the conventional concrete: For 7 days curing period, the strength of the concrete is increased about **9.87%, 19.23%, 9.48%, and 6.19%** for 10% 20%,30% and 40 % replacement of Granite Powder respectively when compared with that of

conventional concrete.For 14 days curing period, the strength of the concrete is increased about **10.11%,11.44%,18.08%** and **9.58%** for 10%, 20% 30%, and 40 % replacement of Granite Powder respectively when compared with that of conventional concrete.For 28 days curing period, the strength of the concrete is increased about **6.45%, 12.91%, 6.55%** and **19.65%** for 10%, 20% 30% and 40% replacement of Granite Powder respectively when compared with that of conventional concrete

Table: 7 Split Tensile strength of Cylinders with replacement of Granite Powder

Compressive strength of cubes in N/mm^2				
S.no	**Proportions**	**7 days**	**14 days**	**28 days**
1	OPC + 0% Granite Powder	2.1	2.4	2.9
2	OPC + 10% Granite Powder	2.33	2.67	3.1
3	OPC + 20% Granite Powder	2.6	2.93	3.33
4	OPC + 30% Granite Powder	2.32	2.47	2.71
5	OPC + 40% Granite Powder	1.97	2.17	2.33

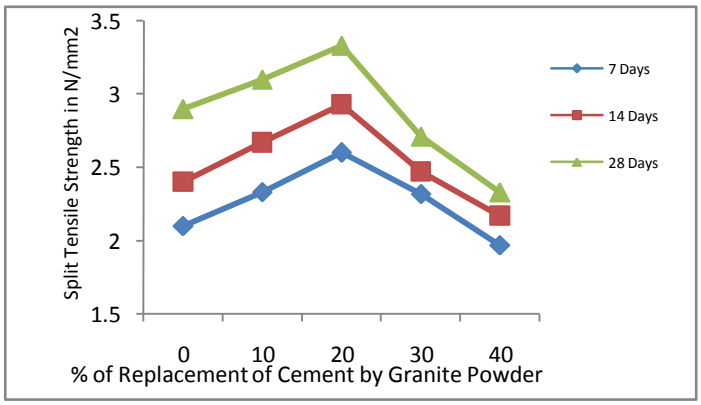

Fig. 2 Split Tensile strength V/s %Replacement of Cement by Granite Powder

V. CONCLUSIONS

The experimental results obtained show that partial substitution of cement by Granite Powder gives better result over the verified range from 0%, 10%, 20%, 30% and 40% replacement. The conclusions are drawn as below:

1. From the result tables, it is concluded that the in a concrete mix 20% replacement of cement by Granite Powder has shown good results in Compressive strength for 7,14 and 28 days curing period.
2. The increase in Compressive strength for 20% replacement of Granite Powder was observed in the range of 13.11% compared to conventional concrete.
3. The increase in Split Tensile strength for 20% replacement of Granite Powder was observed in the range of 12.91% compared to conventional concrete.
4. There is marginal decrease in compressive and Flexural strength by further replacement of Granite Powder
5. Up to 20% replacement of Cement by Granite Powder Can be used for structural elements.

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